matter to write about—rarely anything novel—or can produce doctrine worth consideration. Usually they are but dealers in hashed mutton; they may spice it pleasantly but it is still hash. "It is astonishing what nonsense able men will sometimes write, just because they don't know even the elementary laws of scientific investigation," said Warde Fowler.

I have a letter of his before me, from Kingham, Chipping Norton, dated July, 1913, acknowledging a pamphlet on Nature Study which I had sent to him:—

> I must confess (he writes) to an innate aversion from "Nature Study" in inverted commas and capital letters, *i.e.* as practised in too many schools, because I know that the teachers are quite ready to "teach" what they don't understand a bit and that the only person who can really help the children in these things is one who is learning himself all the time and learning not only from books but using them just as a help. I am very glad to see that you have the same kind of feeling.

Then he speaks of his work in the village school:—

> This week, for example, I have given away two copies of my recent book on this village (which is sought after in the village) as prizes for accounts of the growth of corn (which is growing all around us in different stages) from the seed to the fruit, with specimens. Two girls won the prizes and there were some dozen good answers. The boys seemed more interested in the processes of agriculture than in the growth of the plant and the boys are fewer in number than the girls. I myself have learnt much that I did not know before and so has the schoolmaster. They were all silent or in difficulties about the bloom of the corn and no wonder. What a number of beautiful and interesting things there are to be learnt about it. To-day I have been learning something about the corn smut and turned out a book about diseases of cereals which I had hardly opened since I wrote my "Roman Festivals" and wanted to know something about the robigo, for the Festival of Mildew (Robigalia). One wants a microscope, however, to interest children in such things as that.
>
> I feel as if I should like to go on talking to you but I must be content with thanking you for your reminiscence of my young friend Jim Holmes, for whom I still have a sneaking fondness, as the only (or almost the only) creature of my brain.

In the "Roman Festivals," a work of marvellous erudition and research, he devotes quite a long section to the discussion of the Robigalia and remarks that "the red mildew was at times so terrible a scourge that the Robigalia (April 25) must in early Rome, when the population lived on corn grown near the city, have been a festival of very real meaning. A red dog was sacrificed to Robigus, the spirit who works in mildew. Nowadays nothing that happens in agriculture is marked by sacrifice."

Whether we think of Warde Fowler as literary man or naturalist, however, for the man who could write:—

> I will tell you that the joy of discovering something that you did not know before is in my experience very great and that the joy of finding that so far as your knowledge goes no one ever found it out before is far greater,

we shall long keep a place in our memory. Oxford will best serve his memory by increasing the number who can have that joy, as to-day, it may be feared, we are farther off than we ever were from that "general and vehement spirit of search in the air," which Lord Morley long ago proclaimed to be our prime need: not a few schools, too, are aiming at a classical revival; the meaning of science is not yet with them generally.

H. E. A.

Ionisation Potential and the Size of the Atom.

It is known that there is for different elements a relation between the ionising potential and atomic volume, the one increasing as the other diminishes. Hughes in his book on "Photo-electricity" (p. 51) indicates that the work in removing an electron wholly from an atom might be expected to vary inversely as the radius. In other words, the ionising potential might be inversely proportional to the cube-root of the atomic volume.

Now W. L. Bragg, in the *Philosophical Magazine* (August, 1920), has given the diameters of atoms in Ångstrom units (10^{-8}cm.), on the assumption of close packing in crystal structure. The diameter which he determines is more strictly the distance from centre to centre of contiguous atoms of the same kind. The dimensions which he thus found are far smaller than those deduced from calculations by kinetic theory.

It appears desirable to make a comparison of the ionisation potentials (1) with the diameters as given by W. L. Bragg, and (2) with the cube-root of the atomic volume.

In the subjoined table the name of the element, the ionisation potential, and Bragg's diameter ($\times 10^8$), are set forth in the first three columns. The product of the diameter and ionising potential appear in the fourth column. The cube-root of the atomic volume is stated in the fifth column, and its product with the ionisation potential in the sixth column.

I. Element	II. Ionisation potential	III. Diameter $\times 10^8$	IV. II. × III.	V. Cube root of atomic volume	VI. II. × V
Group I.					
Na	5·11	3·55	18·1	2·87	14·7
K	4·32	4·15	17·9	3·57	15·4
Rb	4·16	4·50	18·7	3·81	15·9
Cs	3·88	4·75	18·4	4·12	16·0
		Mean	18·3	Mean	15·5
		Range	0·8	Range	1·3
Group II.					
Mg	7·61	2·85	21·7	2·40	18·3
Ca	6·09	3·40	20·8	2·96	18·0
Sr	5·67	3·90	22·2	3·25	18·4
Ba	5·19	4·20	21·8	3·31	17·2
		Mean	21·6	Mean	18·0
		Range	1·4	Range	1·2
Group II.B.					
Zn	9·35	2·65	24·8	2·09	19·5
Cd	8·95	3·20	28·6	2·35	21·0
Hg	10·38			2·45	25·4
Group III.B.					
Tl	7·3	4·50	32·8	2·58	18·8
Group IV.B.					
Pb	7·93	3·80	30·1	2·63	20·8

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		Group V.A.			
As	11·5	2·52	29·0	2·36	27·2
				or 2·52	or 29·0
P	13·3			2·37	31·5
				or 2·57	or 34·2
		Group VI.			
S	8·30	2·05	17·0	2·50	20·8
	or 12·2	2·05	or 25·0	2·50	or 30·4
		Group VII.A.			
I	10·1	2·80	28·3	2·95	29·8
	or 8·0	2·80	or 22·4	2·95	or 23·6
		Inert Gases.			
He	25·4			2·86	73·0
Ne	16	1·30	20·8	2·67	42·8
A	12	2·05	24·6	3·03	36·4

In the first group of the periodic table the products shown in each of the fourth and sixth columns of the above table are fairly concordant, so that we may conclude that the work done in the removal of an exterior electron is nearly proportional inversely as the radius.

The same remark applies to four elements of the second group, while the members of sub-group B diverge considerably from the values for the A group. According to Urbach (*Phys. Zeit.*, February, 1921, p. 116), the elements of the B sub-group have a double ring of electrons in the outer zone, while those of the A sub-group have a single ring. In the case of the inert gases, neon and argon, the diameters estimated by Bragg give products in the fourth column in far better accord with theory than those found from the cube-root of the atomic volume set forth in the sixth column.

The values for certain elements in groups iii.–vii. are given in the table for comparison, but our knowledge of ionising potentials is as yet too fragmentary to permit of any definite conclusions.

The ultimate solution of this problem may involve calculations of the character given by Sir J. J. Thomson in his recent paper in the *Philosophical Magazine* (March, 1921, p. 526).

I am indebted to Prof. A. Ll. Hughes for his assistance in endeavouring to collect the most trustworthy values for the ionising potentials.

A. S. EVE.

Macdonald Physics Building,
McGill University, Montreal, June 6.

A Novel Magneto-Optical Effect.

THE interesting observation recorded by Prof. Elihu Thomson in NATURE of June 23, p. 520, seems likely to have a bearing on the old Reichenbach experiments, which were for the most part disbelieved by orthodox science, but on which Sir William Barrett and others made some careful observations, to ascertain what truth there might be in them. The effects could not be denied, but they were capricious; and in view of Prof. Elihu Thomson's discovery, it seems possible that the luminosity may have been visible to sensitive percipients when there was a trace of magnetic dust in the room and when other light was not excluded. The obvious precaution of excluding other light may have been the condition which militated against the examination of the phenomenon, which it was then thought was presumably of a subjective character.

OLIVER LODGE.

June 25.

Helicopters.

ONE often sees published statements to the effect that a helicopter has been invented and that wonderful things are expected of it. If the design gets as far as an actual trial a few alterations are found to be required, and then nothing more is heard of the matter.

To make a machine which without an extravagant expenditure of power will raise itself vertically and remain poised in the air is possible and most desirable, and the many failures in the attempt to do this are all attributable (omitting mistakes in mechanical design) to the same cause, namely, that of giving an insufficient area to the lifting surface.

The sort of area required may be gathered from the following illustration. Let two aeroplanes facing in opposite directions be connected by a few hundred yards of light line joining their wing-tips. The machines so connected could rise and circle round each other without much difficulty. When in the air the line might be hauled in until the wing-tips were almost in contact, and in this condition the combined machines would form a helicopter. There would be no banking, as the connecting line would take the centrifugal force, but more power would be required than when the machines were flying independently on account of the lower speed and efficiency of the inner pair of wings.

The function of a screw or lifting surface is to generate a downward current of air, the reaction of which on the surface shall be equal to the weight supported. If L^2 is the cross-section area of this current (dependent on, though not identical with, the area of the lifting surface), V its velocity, and W the weight, $L^2V^2 \times$(constant somewhat greater than half the density of air)$=$W. Hence LV is a constant, and V is inversely proportional to L.

The power required to maintain the current is WV, and can therefore be reduced by making L/V large.

For instance, if W can be sustained on a current of area L^2 by P horse-power, only half this power would be required if the current area were $4L^2$.

A. MALLOCK.

A Physical Interpretation of the Energy Quantum.

THE work of Bohr (*Phil. Mag.*, 1913–15) indicates that we may assume stability only for *some* electronic orbits, *i.e.* amplitude changes occur discontinuously. We arrive at a similar conclusion in the case of the vibrating atoms of solids if we accept the quantum explanation of the change in their specific heats with temperature.

It is here suggested that the amplitude of a periodic disturbance in the æther can alter only by definite amounts which depend on its frequency, so that as soon as any part of a wave-front meets with something that is capable of inducing a decrease in amplitude, such as a suitably situated electron, that part suffers a definite decrease of amplitude, which extends back into the wave-train (uniformly in all directions in an isotropic medium) to the extent of one quantum. The æther is relieved of its energy of strain, not continuously, but in quanta.

With the modification suggested above the wave theory renders understandable, on one hand, phenomena such as interference, and, on the other, phenomena such as the photo-electric effect, a detailed discussion of which is here impossible owing to lack of space.

More light might be thrown on this subject by a mathematical treatment.

IAN AUCKEN.

The County School, Long Eaton,
June 13.

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